5. Woodfuel and producers' livelihoods in the Congo Basin[1]

Jolien Schure
Centre for International Forestry Research (CIFOR), Wageningen University, Forest and Nature Conservation Policy Group (FNP), P.O. Box 47, 6700 AA Wageningen, the Netherlands; jolien.schure@wur.nl

Abstract

Fuelwood and charcoal are often among the first forest products to be mentioned that provide income to the poor. However, there is little quantitative data about the exact contribution made by these products in terms of household income and how they may help to reduce poverty. The objective of this study was to gain a better understanding of the contribution made by the commercial woodfuel sector to the livelihoods of producers around Kinshasa, capital of the Democratic Republic of Congo. Surveys and interviews with fuelwood and charcoal producers in the supply zones of Kinshasa indicate that (1) profits from fuelwood (USD 288 per year) and charcoal (USD 405 per year) represent a considerable part of the average household income (47% and 75% respectively); (2) annually, the poorest households produce less than half the amount of charcoal than the richest income group, but there is no significant difference between income groups for fuelwood; and (3) woodfuel revenues contribute to both poverty mitigation (used for basic needs such as food, education and healthcare) and poverty elimination (providing capital for investment in other economic activities), and hence livelihood diversification, for 72% of the fuelwood producers and 91% of the charcoal producers. In conclusion, woodfuel revenues contribute to poverty reduction, but the overall income of producers is still low and the poorest seem to benefit least. Overharvesting takes place on a large scale, which poses a risk to the sustainability of this livelihood activity.

Keywords: fuelwood, charcoal, Democratic Republic of Congo, poverty reduction, forest products

5.1 Introduction

Woodfuel (see Box 5.1) is often put high on the list of forest products that provide monetary and non-monetary values to the poor. In the absence of an accessible and

---

[1] This work was first presented at the workshop 'Exploring the Forest-Poverty Link' organised by the Poverty Environment Network (PEN), 13-14 June 2011, Norwich, UK. A longer version of this chapter, in co-authorship with K. Freerk Wiersum and Patrice Levang, has been submitted to World Development.

B. Arts et al. (eds.), *Forest-people interfaces: Understanding community forestry and biocultural diversity*,
DOI 10.3920/978-90-8686-749-3_5, © Wageningen Academic Publishers 2012

Box 5.1. Some definitions.

Woodfuel: all types of biofuels originating directly or indirectly from woody biomass, including fuelwood and charcoal.

Fuelwood: woodfuel in which the original composition of the wood is preserved, including wood in the raw and residues from wood-processing industries.

Charcoal: the solid residue derived from carbonisation, distillation, pyrolysis and torrefaction of fuelwood.

(Food and Agriculture Organization, 2004).

affordable alternative energy source, an estimated 83% of the population in sub-Saharan Africa depend on woodfuel for cooking (Daurella and Foster, 2009). This consumption of fuelwood and charcoal represents 90% of all wood exploitation in Africa (Food and Agriculture Organization, 2011). In the Congo Basin, the second largest tropical forest reserve in the world after the Amazon rainforest, the impact of the woodfuel sector on the natural resource base is most visible around urban areas, in savannah zones and near protected areas. Urban centres in the Democratic Republic of Congo (DRC), the Republic of Congo and Cameroon show a shift from consumption of fuelwood to charcoal (Schure *et al.,* in press). Woodfuel not only serves as an energy source, but its production and trade offer income opportunities, especially with the currently increasing prices in cities, where there is little access to alternative sources of energy (Marien, 2009).

The DRC is among the poorest countries in the world, ranking 168th of 169 countries in the Human Development Index, which measures health, education and income (UNDP, 2010). The country has roughly 130 million hectares of tropical forest, amounting to 60% of the Congo Basin forests. The main question is how this abundance of resources can effectively contribute to poverty reduction. On forest products, the literature is divided into one group that believes the value of these products will give communities revenues, and therefore incentives to protect the forest (e.g. Nepstad and Schwartzman, 1992; Plotkin and Famolare, 1992), and a second group that believes open access will lead to overharvesting and elite capture of high-value products, and at best may provide a safety net function for the poor (Belcher and Schreckenberg, 2007; Wunder, 2001).

Although it is generally believed that woodfuel can provide important benefits to households, there are few quantitative studies on the exact contribution in terms of income and how it contributes to livelihoods (Arnold *et al.*, 2006). The extent to which the sector provides employment is often not adequately reflected in statistics because woodfuel production and trade take place mainly in the informal sector (Openshaw, 2010). Another aspect is the lack of understanding of the actual returns for producers, because detailed data on the cost structure are not available (Neumann and Hirsch, 2000). The increasing prices of woodfuel may suggest that there are interesting profits to be made. However, in the absence of alternative income opportunities and a relatively low entry threshold to woodfuel production, competition may be fierce and the actual profits small (Arnold *et al.*, 2006). Some recent studies offer further insights into the extent to which the woodfuel sector contributes to poverty reduction. For the whole of sub-Saharan Africa it is estimated that 13 million people could be employed in the biomass (mostly wood) energy sector (Openshaw, 2010), offering income opportunities to the rural poor (Shackleton *et al.*, 2007). Around urban centres in Uganda, charcoal revenues were found to contribute positively to household cash incomes by on average USD 122 per year (Khundi *et al.*, 2011). This seems to be of particular importance to households with low agricultural productivity. However, the poorest of the poor often do not participate in charcoal production (Khundi *et al.*, 2011). In Malawi, charcoal revenues contributed to lower income households (Zulu, 2010). This illustrates that there can be various outcomes with regard to the contribution of woodfuel revenues to people's livelihoods. Better context-specific knowledge about the driving forces and the socioeconomic aspects of woodfuel production could therefore assist in developing appropriate actions for environmental and livelihood needs.

5.2 Theoretical outlook

The concept of non-timber forest products (NTFPs), the subject of this part of the book, addresses the role of forest products in the development of rural forest communities, often linked to questions about co-benefits for environmental conservation (see Ros-Tonen in this volume). NTFPs were initially defined to encompass 'all biological materials other than timber which are extracted from natural forests for human use. These include foods, medicines, spices, essential oils, resins, gums, latexes, tannins, dyes, ornamental plants, wildlife (products and live animals), fuelwood and raw materials, notably rattan, bamboo, smallwood and fibres' (De Beer and McDermott 1989: 17). Over the past two decades, scholars have proposed many different definitions of NTFPs, often linked to certain perceptions of why the concept is important. This has led to ambiguity, both about which products are included or excluded (mainly animal products and wooden materials) and what the resource base of NTFPs is (forests, degraded forests, agroforestry, plantations) (Belcher, 2003; Ros-Tonen and Wiersum, 2005).

The status of woodfuel (charcoal and fuelwood) within the NTFP concept is often unclear. This was already noted by De Beer and McDermott (1989: 17) when they first presented the concept: 'Clearly the distinction between "timber" and "non-timber" can become blurred, as when such borderline cases as large-scale fuelwood harvesting for urban markets and the use of timber in rural house construction are considered'. In the literature about woodfuel, authors either include woodfuel as NTFPs by referring to the definition 'everything but timber', or exclude it by referring to 'non-wood forest products', meaning 'everything but wood'. Others avoid the debate entirely by discussing the product separately or by referring to 'forest products' more generally. The Food and Agricultural Organization of the United Nations (FAO) chooses to refer to 'non-wood forest products' in its definition and data collection instead of NTFPs, and placed charcoal and fuelwood into separate categories because of their overall large volumes (Killmann, 2009). In the debate on the possible benefits of NTFPs, woodfuel has been largely ignored. During the last four decades, the focus of attention has alternated between NTFPs and woodfuel.

In the 1970s, concerns arose about woodfuel shortage, or 'the other energy crisis', triggered by the oil crisis (Eckholm, 1975). Woodfuel became a priority on the policy agendas and large-scale fuelwood plantations and efficient-stove projects were implemented to assure woodfuel supplies. A decade later, in the mid 1980s, the woodfuel crisis did not materialise on a global scale because increasing urbanisation and rising incomes had slowed the demand in many regions (Arnold and Persson, 2003). It was found that woodfuel actually often came from sources other than forests (such as trees on agricultural land, village woodlots, homegardens and public land) and, in cases where local households were faced with less supply, they often coped by reducing consumption (Trossero, 2002). By the late 1980s, interest in the 'woodfuel crisis' and related intervention schemes had already waned considerably (Arnold *et al.*, 2006).

In the early 1990s, the years leading up to the 1992 UN Conference on Conservation and Development, NTFPs became more visible on the development and environment agenda following the publication of Peters *et al.* (1989) which indicated that the value of NTFPs can be higher than that of wood. The reasons why woodfuel was largely ignored in this new NTFP agenda were that it was primarily conceived of as a subsistence resource and that, as a wood product, it did not present a sustainable harvesting scenario (Sills *et al.*, 2011). The quickly increasing number of NTFP studies since the mid 1990s provided insights into the roles of NTFPs related to agriculture, conservation and poverty reduction. It became clear that forests play diverse roles in local livelihoods and the earlier high expectations about environment and development reconciliation were lowered (Arnold and Perez, 2001; Ros-Tonen and Wiersum, 2005). Moreover, there was recognition for the growing group of urban and peri-urban residents involved in NTFP use. The earlier debate on which products to include in or exclude from the NTFP concept and where the limits of the resource base are has now been replaced by a much broader perspective: 'a range of forest products (from medicinal plants to timber), a range of forest management intensities (from pure extraction to intensive forest management), and a range of markets (from international to local)' (Sills *et al.*, 2011: 43). This new understanding of NTFPs favours a 'resource-in-context' approach that focuses on the entire landscape and livelihoods (Ros-Tonen and Wiersum, 2005).

In the 2000s, it became obvious that environmental and social issues remain and that the story behind woodfuel supply is more complex than initially thought. On an international level, woodfuel gradually came to be seen as a potential modern renewable energy source (Trossero, 2002). Climate change politics concerning carbon sequestration programmes took an interest in benefits to be gained at the production and consumption level. For developing countries, it was recognised that high woodfuel demand, often related to clearing land for agriculture, could have serious impacts. This is of special concern for Africa; the only continent where household woodfuel consumption is expected to increase in the coming decades and where particular attention should be paid to the increasing urban demands of charcoal (Girard, 2002). A review of the woodfuel sector of 18 African cities by the FAO (2010) showed a wide variation in possible environmental outcomes, ranging from low pressure and weak impact to accelerated degradation of peri-urban areas. A similar variation is expected for the producers' livelihood outcomes. In this respect, woodfuel studies can learn from the experiences of NTFP studies by focusing on livelihoods and following a resource-in-context approach (Ros-Tonen and Wiersum, 2005).

Woodfuel production is often part of the livelihood strategies that people develop and use to earn a living. Livelihood is defined as 'the control an individual, family or other social group has over an income and/or a package of sources that can be used or changed to maintain a living' (Blaikie *et al.*, 1994: 9). The combination of diverse income-generating activities, often adding non-agricultural sources of income to rural livelihoods, contributes to 'livelihood diversification', which is defined as 'the process by which rural families construct a diverse portfolio of activities and social support capabilities in order to survive and to improve their standards of living' (Ellis, 1998: 1).

Shackleton *et al.* (2008: 519) classified the role of forest products in four different types of livelihood strategies (c.f. Ros-Tonen, Chapter 2 in this volume):

- Specialisation: the extraction of forest products is a primary activity that contributes over 50% of household income.
- Diversification 'by choice': the extraction of forest products is a variable activity by choice among several other income-generating activities that provides less than 50% of household income.
- Coping or 'diversification by necessity': forest products represent the most important source of income (over 50% of an overall low household income), but their extraction is mainly a response to a lack of alternatives, and as such can become a long-term strategy.
- Survival: forest products provide less than 50% of household income, generate low returns, are a last resort, and function as a safety net.

This typology of different livelihood strategies is useful for identifying the contribution made by forest products to the household portfolio and to poverty reduction. Poverty reduction can result either in poverty mitigation or poverty elimination. Poverty mitigation or avoidance can be considered as 'the use of forest resources to meet household subsistence needs, to fulfil a safety net function in times of emergency, or to serve as a "gap filler" in seasonal periods of low income'. Poverty elimination is considered as 'the use of forest resources to help lift the household out of poverty by functioning as a source of savings, investment, accumulation, asset building, and lasting increases in income and well-being' (Sunderlin *et al.*, 2005). Wealthier and poorer households are likely to gain different benefits from forest products. The wealthier households may be able to invest in cash-generating opportunities and bring these products to the urban markets where they sell for higher prices. Poorer households, on the contrary, may depend more on forest products for subsistence income and their opportunities to sell these products are likely to be restricted to local markets (Paumgarten and Shackleton, 2009).

Building upon the insights derived from NTFP and livelihood studies, this chapter assesses the role of woodfuel production and trade in local livelihoods. It takes a resource-in-context approach and highlights issues of urban woodfuel production and the role of woodfuel in the poverty reduction strategies of producer households.

5.3 Methodology

The objective of this study was to gain a better understanding of the contribution made by the commercial woodfuel sector to the livelihoods of producers around Kinshasa, the capital of the DRC. More specifically, it aimed to find answers to the following research questions:

- What is the role of woodfuel production in the livelihood strategies of producers in the supply zones of Kinshasa?
- What are the amounts and net revenues from charcoal and fuelwood production for the producers?
- How do these woodfuel revenues contribute to poverty mitigation and poverty elimination?

Answers to these questions would improve understanding of how woodfuel production interacts with other livelihood strategies of producers, how important it is to their household income and whether it has the potential to reduce poverty.

Study area

Kinshasa is the capital of the DRC and is situated on the south bank of the Congo River. With a population of 5.8 million inhabitants, Kinshasa is one of the biggest cities in sub-Saharan Africa (Division Urbaine de l'Intérieur, Décentralisation et Sécurité, 2010). The city's population is young, with half of the inhabitants under 20 year old. It is also a poor population. The poverty rate – defined by UNDP (2009) as the proportion of people living on less than USD 1.25 a day – was 41.6% in 2005 and underemployment rates are high (UNDP, 2009). The economy is dominated by the informal sector, which provides 89.5% of household income. The woodfuel supply zone of Kinshasa stretches to the southwest and northeast over an average distance of 102 km for fuelwood and 135 km for charcoal. The landscape is dominated by hilly sites and the Plateau Batéké, which is mainly savannah with pockets of forests. The provinces of Kinshasa and Bas-Congo provide most of the woodfuel (43% and 34% respectively) and most producers supplying Kinshasa are based in these two provinces (Table 5.1). Some supplies (24%) enter via the Congo River from the more distant provinces of Bandundu, Equateur and Orientale, up to 1000 km away (Schure *et al.*, in press) (Figure 5.1).

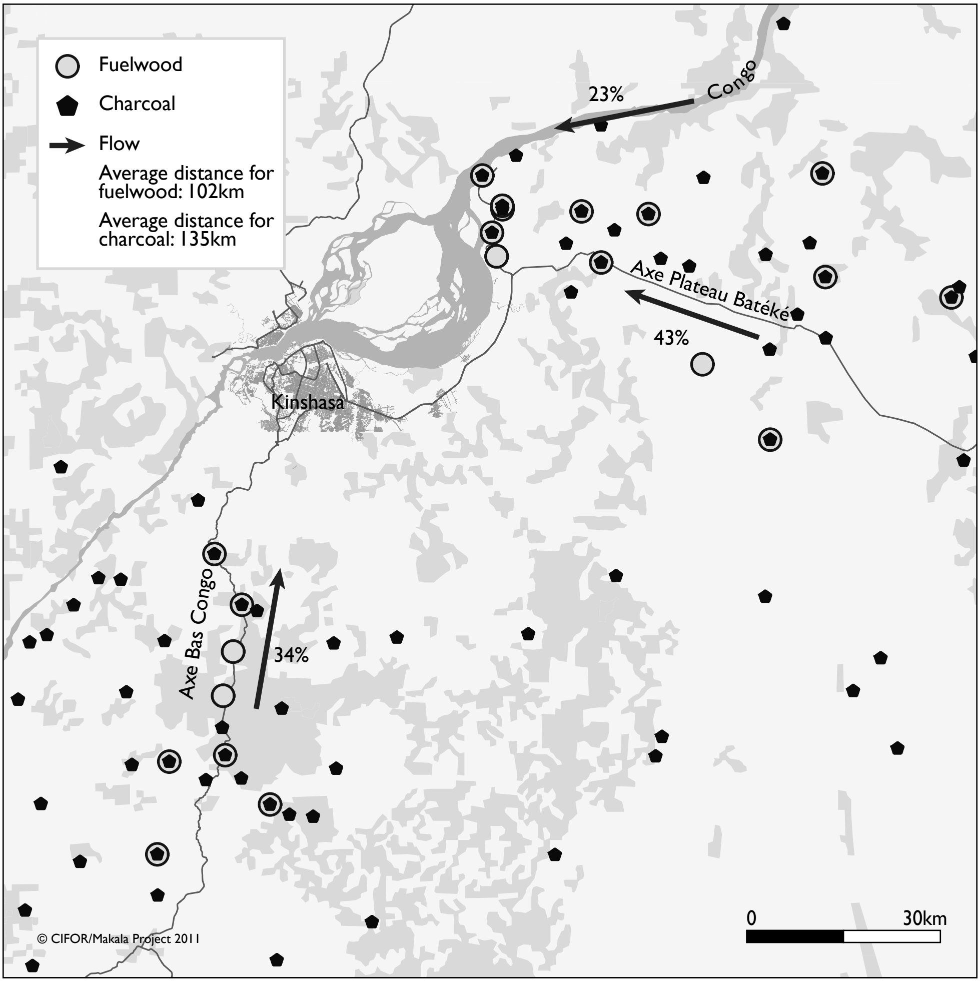
○ Fuelwood
⬟ Charcoal
➔ Flow
Average distance for fuelwood: 102km
Average distance for charcoal: 135km
23%
Congo
Axe Plateau Batéké
43%
Kinshasa
Axe Bas Congo
34%
0
30km
© CIFOR/Makala Project 2011

Figure 5.1. Woodfuel flows in the Kinshasa supply zone.

Table 5.1. Socioeconomic statistics for Kinshasa and Bas-Congo provinces (UNDP, 2009).

	Kinshasa province	**Bas-Congo province**	**DRC**
Area	9,965 km^2	55,920 km^2	2,344,858 km^2
Population	5.8 million	3.2 million	64.3 million
Poverty rate[1]	41.6%	69.8%	71.3%
Average household size	6.0	4.8	5.3
Primary school education rate	74.8%	71.1%	76.3%
Underemployment rate[2]	53.1%	73.4%	72.7%
Origin of household income			
Informal sector	89.5%	93.6%	94.6%
Public sector	6.1%	4.0%	3.6%
Private sector	4.4%	2.4%	1.8%
Average monthly household income	USD 84	USD 37	USD 42

[1] Poverty rate: proportion of people living on less than USD 1.25 per day.

[2] Underemployment rate: proportion of people who involuntarily work less than 35 hours a week or earn less than the minimum salary.

Methods

Between September 2009 and February 2010, surveys were conducted among 200 fuelwood collectors and 392 charcoal producers. The surveys addressed economic, social and environmental aspects of woodfuel production and trade. The woodfuel producers were randomly selected in 20 villages in the Kinshasa province and 20 villages in the Bas-Congo province. From May 2010 until April 2011, 10 villages with a total of 50 producers were subject to a year-round survey. This survey helped, among other things, to capture fluctuations of quantities and prices throughout the year and to determine the cost structure of the woodfuel trade.

The collected data were analysed using the statistical software package SPSS (16.0). Descriptive statistics were used to picture the producers' socioeconomic profiles. The producers' annual profits were calculated as the sum of revenues minus the various costs involved in the production process:

> Annual Profit = (Units sold × Average selling price) – (Transportation costs + Taxes + Labour costs + Tool and equipment costs + Costs to access the resource)

Statistical analyses used to compare differences between groups (type of product, income level) are the chi-square test for independence and one-way between-groups analysis of variance (ANOVA). For the continuous data on production quantity, the logarithm was used to transform the data into normal distribution to meet the assumptions for the parametric test (ANOVA).

5.4 Results

The role of woodfuel in overall livelihood strategies

Producers in the supply zones of Kinshasa are mostly villagers who live and produce in their village of origin. Fuelwood production, from cutting the wood to packing the bundles for sale, is often done by family members; sometimes other villagers are hired for a daily fee or compensation in kind. Urban-rural migration for production purposes has been observed to some extent, especially to meet commercial demand for fuelwood, for example by bakeries. The production cycle of charcoal, from cutting the wood to packing the bags, involves mainly local men, who are paid a daily fee (or sometimes a percentage of the production) by the landowner or the 'head producer'. Also common is the system of *ristourne*, or labour groups, by which roughly ten producers work in turns to build one member's charcoal kiln. The host producer provides drinks and food and reciprocates in labour to other members of the group. Some urban citizens have specialised in charcoal production because of limited employment opportunities in town. They mainly function as intermediaries and financiers of activities, and hire local villagers to produce the charcoal.

Producers of woodfuel are representative of average rural households in terms of working-age population and ethnic groups. The average household income of producers in the Kinshasa supply zone is less than USD 1.25 per day (poverty line standard), which is similar to other rural households in the area (Table 5.2).

For most producer households, agriculture is the primary income-generating activity besides woodfuel. Other revenues mainly come from petty trade, timber exploitation and livestock. Non-wood forest products may have important non-monetary values and provide an additional income for around 7% of all producers, but are rarely the primary source of income. Only a few producers have some paid seasonal work. This confirms the overall absence of employment opportunities in

Table 5.2. Sociodemographic information on fuelwood and charcoal producers.

	Producers Kinshasa region	
	Fuelwood producers	**Charcoal producers**
Women producers (%)	5.8	3.4
Age (years)	33.6	34.2
Working experience (years)	7.5	7.1
Household size (number of members)	6.1	5.4
Household income (USD/month)	51	45

the region and the fact that virtually all producers depend on more than one activity for their household income (Table 5.3). Overall, the income-generating activities of charcoal and fuelwood producers look quite similar, but there is a significant difference between their primary activities ($P=0.018$) [chi-square test: $\chi^2(1, n=463) = 5.6, P=0.018$, Cramer's $V=0.011$ (small effect size)]. Charcoal producers do relatively more farming than fuelwood producers. Timber exploitation is more common among fuelwood producers and fuelwood production by those involved in timber exploitation is likely to be a by-product of this activity, in which case the tree trunk is sold as log or sawn wood and the smaller branches and waste wood serve as fuelwood.

Woodfuel production is often related to clearing land for agriculture, either by the woodfuel producer or the landowner. Over half (52%) of the charcoal produced for the Kinshasa market comes from agricultural land, 28% from forests and 16% from other sources, such as (village) plantations. Fuelwood is mainly collected on agricultural land (62%), followed by forests (30%). Comparing these practices with the preferences voiced by producers yielded quite a difference: the preferred places for woodfuel production are forests (40%), plantations (37%) and agricultural land (20%). This suggests that producers have difficulties finding or accessing new woodfuel resources and that there is a large potential for woodfuel plantations. According to 77% of the producers, the distance to the production sites has increased over the past five years. Resource scarcity is also reflected in the proportion of producers (12.6%) who stated that they have been involved in conflicts surrounding woodfuel production. Paucity of the resource is the main cause of such conflicts.

Table 5.3. Income-earning activities mentioned by fuelwood and charcoal producers (% of producers who list this activity among their five main income-earning activities).

	Fuelwood producers	**Charcoal producers**
Agriculture	89.3%	94.2%
Petty trade	23.5%	20.9%
Timber exploitation	29.1%	10.8%
Livestock	10.2%	9.0%
NWFP[1]	7.7%	5.5%
Craftworker	5.6%	0.8%
Paid seasonal labour	3.1%	1.6%
Fishing	0.0%	1.1%

[1] NWFP refers to the collection of all non-wood forest products, including honey and bushmeat.

Production quantities and net revenues

Fuelwood producers produce 10.6 tonnes of wood per year (SD = 16.8) mainly meant for sale. Only 6.8% of the production is for self-consumption, in-kind payments or gifts. Of all the commercialised fuelwood, roughly half is sold in the village and the other half is brought to the urban market. The average selling price is CDF 2,236 (USD 2.7) per bundle, with a bundle weighing 43.3 kg on average.

On average, each charcoal producer produces 8.2 tonnes of charcoal per year (SD = 9.9). The charcoal is mainly sold for cash; only minor quantities (less than 4.6%) are bartered for goods or used for own consumption. A third of the producers sell the charcoal directly in the village and two-thirds of them sell the bags at the urban market. The average price per bag is CDF 7,290 (USD 8.8), with a bag corresponding to 57.0 kg on average.

The costs of production over a 12-month period are highest for transportation, followed by labour, tools, costs to access the resource base and taxes (Figure 5.2). Taxes are likely to be underrepresented because the informal taxes collected on the roads are often paid by the transporter and therefore included in the price of transportation. As may be expected, the costs of producing charcoal (73% of total revenues) are higher than the costs of fuelwood production (57% of total revenues).

Fuelwood harvest and sales provide producers with an annual net income of CDF 237,974 (USD 288) or CDF 19,831 (USD 24) per month, calculated as follows:

> Annual Profit = (Units sold × Average selling price) – (Transportation costs + Taxes + Labour costs + Tools and equipment costs + Costs of access to resource) = (228 × 2,236) – (107,952 + 17,160 + 84,696 + 17,133 + 44,893) = CDF 237,974 (USD 296) per year.

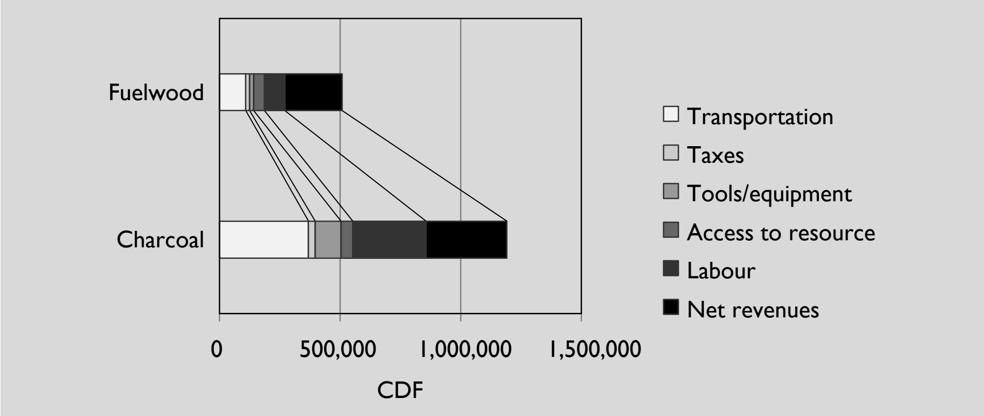

Figure 5.2. Costs and net revenues (CDF per year) to the producer of fuelwood and charcoal production.

This represents 47% of the average household income. The average charcoal producer's net revenues are CDF 334,961 (USD 405) per year or CDF 27,913 (USD 34) per month:

> Annual Profit = (Units sold × Average selling price) – (Transportation costs + Taxes + Labour costs + Tools and equipment costs + Costs of access to resource) = (163.5 × 7,290) – (368,390 + 28,490 + 304,393 + 107,103 + 48,578) = CDF 334,961 (USD 405) per year.

This represents 75% of an average charcoal producer's household income.

A one-way between-groups ANOVA was conducted to explore the impact of income level on the production quantity of woodfuel. For fuelwood production, there was no significant difference in production quantity between income groups. For charcoal production there was a statistically significant difference ($P<0.001$) in production quantities for the four income groups: F(3, 348) = 17.7, $P=0.000$. The mean production was lowest for the low income group and highest for the highest income groups (Table 5.4). The only non-significant difference is between groups three and four, suggesting that producer households with a monthly income over USD 50 can produce optimal quantities of charcoal.

Contribution by woodfuel revenues to poverty reduction

The benefits from woodfuel income can be divided into short-term benefits, for example the money used for daily needs, and the long-term benefits that may be obtained from investments made with the revenues. Charcoal making is not

Table 5.4. Mean production of fuelwood and charcoal (tonnes per year) per producer per income category.

Income group	USD/month	Production in tonnes (standard deviation)
Fuelwood		
1+2[a]	<50	11.4 (20.9)
3	51-100	9.2 (10.6)
4	>100	12.4 (11.4)
Charcoal		
1	<11	3.5 (3.7)
2	11-50	7.0 (7.8)
3	51-100	11.4 (13.0)
4	>100	9.6 (8.2)

[a] For fuelwood the one-way between groups ANOVA was conducted with three income groups instead of four (group one and two combined) to meet the conditions for this test.

an easy way to make money (as it involves hard physical labour), but it is quick money in times of need, also called *intervention rapide* by producers. Fuelwood collection can be more of a continuous activity and is less associated with hardship, but like charcoal it is among the very few possibilities for producers to gain cash income. Another important aspect is that the income-generating opportunity of woodfuel does not oblige the farmer to neglect agriculture, which remains the primary activity. Villagers make a clear distinction between the different types of benefits from the two activities:

> If there were only charcoal, the household would have no food! Charcoal doesn't give us *chikwange* [local staple food based on fermented cassava] or [cassava] leaves like our fields do. We make charcoal for one reason: to pay for something.

The revenues from fuelwood and charcoal production are used to pay for daily needs: mainly food (mentioned by 91% of the producers), education (88%) and healthcare (72%). The notion of 'quick intervention' by producers also illustrates that the activity serves as a 'gap filler' in times of need. Woodfuel production takes place during the slack agricultural season, mostly in the period between planting and harvesting when rural households are in need of cash income. This contribution to basic needs and the gap filler function shows a clear role for woodfuel production in poverty mitigation.

The potential contribution made by woodfuel production to poverty elimination can be seen by the fact that 72% of the fuelwood producers and 90% of the charcoal producers invest part of their woodfuel revenues in other economic activities of the household. These investments flow mainly to agriculture (90.9%), with fewer producers indicating reinvestments in petty trade (7.3%), livestock (1.1%) and fishing (0.5%). These investments can be considered as a way to accumulate assets and diversify risks and income opportunities.

5.5 Discussion

The contribution made by the commercial woodfuel sector to the livelihoods of producers in the supply zone of Kinshasa was analysed at three levels: (1) by analysing the role of woodfuel production as part of wider household strategies; (2) by quantifying the production and net revenues; and (3) by investigating how these revenues may affect poverty mitigation as well as poverty elimination.

The livelihoods of producers are characterised by a process of diversification. They combine different activities, with woodfuel adding non-agricultural income to the household. The top four listed income-generating activities besides woodfuel are agriculture, trade, timber exploitation and livestock. Other non-wood forest products (mainly honey and bushmeat) may have important non-monetary value, but are rarely the primary source of income. In terms of the fourfold classification of livelihood strategies by Shackleton *et al.* (2008) – specialisation, diversification 'by choice', coping or 'necessity', and survival – woodfuel production is for most producers a coping or 'necessity' strategy. The product provides the major part of household income and woodfuel production is a response to the lack of other cash-generating activities. Producers are generally involved in it for a long time.

Charcoal and fuelwood production in the supply zone of Kinshasa is mostly oriented towards the market and generating monetary benefits. Producers said that it is not 'easy money', but rather 'quick money', also referred to as *intervention rapide*. In terms of quantifying their financial benefits, it was found that the net benefits of charcoal are higher (USD 405 per year) than those of fuelwood (USD 288 per year). This confirms that charcoal processing is a more attractive option than fuelwood production.

Production quantities vary greatly between producers, confirming that poor producers tend to benefit least, but only for charcoal. This is probably due to the fact that the poorest households lack the financial means needed to sufficiently invest in the relatively high costs of transport, labour and equipment for charcoal production. The poorest households produce less than half of the quantity per month than the richer households. Optimal investments for these activities are made by those in the USD 51-100 per month income category. This is in line with findings on charcoal revenues in Uganda (Khundi *et al.*, 2011) and studies about other high-value forest products that indicate that the wealthier households tend to benefit more (Belcher, 2005; Paumgarten and Shackleton, 2009). In contrast, no significant difference was found in the quantities of fuelwood produced between the different income groups, probably because the initial investments and its value are lower. Further research is needed to gain more understanding about possible underlying factors.

In terms of poverty mitigation, we see that woodfuel revenues contribute to meeting subsistence needs as producers spend part of their income on daily basic needs such as food, education and healthcare. More important, however, is that woodfuel as part of diversified livelihood strategies also seems to provide capital for investments in other activities – mainly agriculture and some petty trade, livestock and fishing – which points towards poverty elimination. In this case, forests provide 'sources of rent extracted and invested in sectors with greater production potentials, allowing for a diversification of income sources' (Wunder, 2001: 1829). Khundi *et al.* (2011: 204) suggest that charcoal revenues assist in filling an income gap for those households with less agricultural production. Our study shows that woodfuel revenues contribute to both income for daily needs and investments in agriculture. The latter is likely to contribute to higher agricultural capacity and productivity.

This contribution of woodfuel revenues to accumulating capital is a key finding, but caution is warranted to avoid overoptimism, for three main reasons:

1. The overall income of producers is still low: 61.0% of producer households have an income of less than USD 50 per month, which reflects the generally high poverty level in the DRC.
2. The poorest seem to benefit less from the woodfuel trade, especially when it comes to charcoal production, where most profits can be made.
3. Environmental costs are not internalised and there is a risk of overharvesting. The latter occurs on a large scale, which poses a risk to the long-term sustainability of this livelihood activity. This may create a poverty trap, because a lack of these earnings also lessens investments in other activities and decreases these accumulated benefits.

5.6 Conclusion

This 'woodfuel in the context of Kinshasa' study highlights the integral part played by woodfuel production in household livelihood strategies that are based mainly on agriculture, and that it provides important benefits to producer households. Woodfuel sales provide households with considerable financial benefits (USD 288 per year for fuelwood and USD 405 per year for charcoal) representing a considerable part of the average household cash income (47% and 75% respectively). The poorest households produce less than half the amount of charcoal than the richest income group (3.5 versus 9.6 tonnes per year per producer), but for fuelwood there is no significant difference between income groups, which might be explained by the lower entry threshold (less investment needed) and the lower value of the product. Woodfuel revenues contribute to both poverty mitigation (as they are used for basic needs, such as food, education and healthcare) and poverty elimination (providing capital for investment in other economic activities), and hence livelihood diversification for 72% of the fuelwood producers and 91% of the charcoal producers.

In conclusion, woodfuel revenues contribute to poverty reduction, but not in a way that reconciles development and conservation efforts. Woodfuel production in the Kinshasa context has a considerable impact on the resource base. In the likely event that demand continues to increase in the near future, those households depending most on woodfuel revenues may end up in a particularly difficult situation, missing out on financial resources for daily needs and investments in other activities. The potential that woodfuel offers to the livelihood of producers in the supply zone of Kinshasa should be central to any future plans for guaranteeing energy supply while maintaining the natural resource base.

Acknowledgements

This study is part of CIFOR's contribution to the Makala 'Sustainable management of woodfuel in the Democratic Republic of Congo' project (2009-2013), an initiative coordinated by the French Agricultural Research Centre for International Development (CIRAD), with financial support from the European Union (see http://projets.cirad.fr/makala). The content of this chapter is the sole responsibility of the author and can in no way be taken to reflect the views of the European Union. The inputs and comments by the participants at the Poverty Environment Network (PEN) workshop (13-14 June 2011, Norwich, UK) are gratefully acknowledged.

References

Arnold, J.E.M. and Perez, M.R. (2001). Can non-timber forest products match tropical forest conservation and development objectives? Ecological Economics 39(3): 437-447.

Arnold, J.E.M. and Persson, R. (2003). Reassessing the fuelwood situation in developing countries. International Forestry Review 5(4): 379-383.

Arnold, J.E.M., Kohlin, G. and Persson, R. (2006). Woodfuels, livelihoods, and policy interventions: changing perspectives. World Development 34(3): 596-611.

Belcher, B.M. (2003). What isn't an NTFP? International Forestry Review 5(2): 161-168.

Belcher, B.M. (2005). Forest product markets, forests and poverty reduction. International Forestry Review 7(2): 82-89.

Belcher, B. and Schreckenberg, K. (2007). Commercialisation of non-timber forest products: a reality check. Development Policy Review 25(3): 355-377.

Blaikie, P., Cannon, T., Davis, I. and Wisner, B. (1994). At risk: natural hazards, people's vulnerability, and disasters. Routledge, London, UK, 284 pp.

Daurella, D.C. and Foster, V. (2009). What can we learn from household surveys on inequalities in cooking fuels in sub-Saharan Africa? World Bank, Washington, DC, USA, 38 pp.

De Beer, J.H. and McDermott, M.J. (1989). The economic value of non-timber forest products in Southeast Asia with emphasis on Indonesia, Malaysia and Thailand. Netherlands Committee for IUCN, Amsterdam, the Netherlands, 175 pp.

Division Urbaine de l'Intérieur, Décentralisation et Sécurité (2010). Tableau statistiques 2009 des services de la population de 24 communes de la ville de Kinshasa. Division Urbaine de l'Intérieur, Décentralisation et Sécurité, Kinshasa, DRC, 6 pp.

Eckholm, E. (1975). The other energy crisis: firewood. Worldwatch Paper 1. Worldwatch Institute, Washington, DC, USA, 22 pp.

Ellis, F. (1998). Household strategies and rural livelihood diversification. Journal of Development Studies 35(1): 1-38.

Food and Agriculture Organization (FAO) (2004). UBET Unified bioenergy terminology. Food and Agriculture Organization, Rome, Italy. Available at: http://www.fao.org/DOCREP/007/j4504E/j4504E00.HTM.

Food and Agriculture Organization (FAO) (2010). Foresterie urbaine et périurbaine en Afrique. Quelles perspectives pour le bois-énergie? Document de travail sur la foresterie urbaine et périurbaine no. 4. Food and Agriculture Organization, Rome, Italy, 95 pp.

Food and Agriculture Organization (FAO) (2011). State of world's forest 2011. Food and Agriculture Organization, Rome, Italy, 264 pp.

Girard, P. (2002). Charcoal production and use in Africa: What future? Unasylva 53(211): 30-34.

Khundi, F., Jagger, P., Shively, G. and Sserunkuuma, D. (2011). Income, poverty and charcoal production in Uganda. Forest Policy and Economics 13(2011): 199-205.

Killmann, W. (2009). Non-wood forest products for livelihoods and sustainable development. In: Spathelf, P. (ed.) Sustainable forest management in a changing world: a European perspective. Springer, Dordrecht, the Netherlands, pp. 83-91.

Marien, J.N. (2009). Forêts périurbaines et bois énergie: quels enjeux pour l'Afrique centrale? Les Forêts du Bassin du Congo. In: De Wasseige, C., Devers, D., De Marcken, P., Eba'a Atyi, R., Nasi, R. and Mayaux, Ph. (eds.) Les forêts du Bassin du Congo – Etat des Forêts 2008. Office des publications de l'Union Européenne, Luxembourg, Luxembourg, pp. 217-230.

Nepstad, D.C. and Schwartzman, S. (1992). Introduction: non-timber product extraction from tropical forests evaluation of a conservation and development strategy. In: Nepstad, D.C. and Schwartzman, S. (eds.) Non-timber products from tropical forests: evaluation of a conservation and development strategy. Advances in Economic Botany 9, New York Botanical Garden, New York, NY, USA, pp. vii-xii.

Neumann, R.P. and Hirsch, E. (2000). Commercialisation of non-timber forest products: Review and analysis of research. Center for International Forestry Research, Bogor, Indonesia, 176 pp.

Openshaw, K. (2010). Biomass energy: employment generation and its contribution to poverty alleviation. Biomass and Bioenergy 34(3): 365-378.

Paumgarten, F. and Shackleton, C.M. (2009). Wealth differentiation in household use and trade in non-timber forest products in South Africa. Ecological Economics 68(12): 2950-2959.

Peters, C.M., Gentry, A.H. and Mendelsohn, R.O. (1989). Valuation of an Amazonian rainforest. Nature 339(6227): 655-656.

Plotkin, M.J. and Famolare, L.M. (1992). Preface. In: Plotkin, M.J. and Famolare, L.M. (eds.) Sustainable harvest and marketing of rain forest products. Island Press, Washington D.C., USA, pp. xiii-xv.

Ros-Tonen, M.A.F. and Wiersum, K.F. (2005). The scope for improving rural livelihoods through non-timber forest products: an evolving research agenda. Forests, Trees and Livelihoods 15(2): 129-148.

Schure, J., Marien, J.N., De Wasseige, C., Drigo, R., Salbitano, F., Dirou, S. and Nkoua, M. (2012). Contribution du bois énergie à la satisfaction des besoins énergétiques des populations d'Afrique Centrale: perspectives pour une gestion durable des ressources disponibles. In: Les Forêts du Bassin du Congo – Etat des Forêts 2010. Office des publications de l'Union Européenne, Luxembourg, Luxembourg, (in press).

Shackleton, S., Campbell, B. and Lotz-Sisitka, H. (2008). Links between the local trade in natural products, livelihoods and poverty alleviation in a semi-arid region of South Africa. World Development 36(3): 505-526.

Shackleton, C.M., Shackleton, S.E., Buiten, E. and Bird, N. (2007). The importance of dry woodlands and forests in rural livelihoods and poverty alleviation in South Africa. Forest Policy and Economics 9: 558-577.

Sills, E., Shanley, P., Paumgarten, F., Beer, J. and Pierce, A. (2011). Evolving perspectives on non-timber forest products. In: Shackleton, S., Shackleton, C. and Shanley, P. (eds.) Non-timber forest products in the global context. Tropical Forest Series. Springer-Verlag, Heidelberg, Germany, pp. 23-51.

Sunderlin, W.D., Angelsen, A., Belcher, B., Burgers, P., Nasi, R., Santoso, L. and Wunder, S. (2005). Livelihoods, forests, and conservation in developing countries: an overview. World Development 33(9): 1383-1402.

Trossero, M.A. (2002). Wood energy: the way ahead. Unasylva 53(211): 3-12.

United Nations Development Programme (UNDP) (2009). Province de Kinshasa: Pauvreté et conditions de vie des ménages. Programme des Nations Unies pour le Développement, Unité de Lutte Contre la Pauvreté, Kinshasa, DRC, 19 pp.

United Nations Development Programme (UNDP) (2010). Human development report 2010. The real wealth of nations: Pathways to human development. United Nations Development Programme, New York, USA, 227 pp.

Wunder, S. (2001). Poverty alleviation and tropical forests – What scope for synergies? World Development 29(11): 1817-1833.

Zulu, L.C. (2010). The forbidden fuel: charcoal, urban woodfuel demand and supply dynamics, community forest management and woodfuel policy in Malawi. Energy Policy 38(7): 3717-3730.